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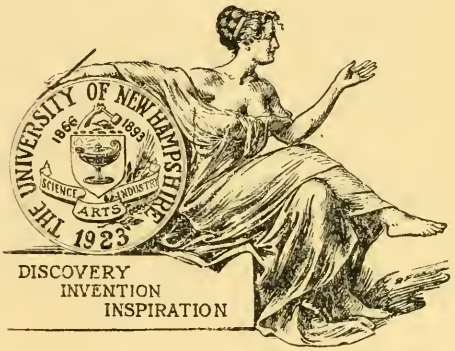

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NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION

REPORT

OF THE

NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION FOR THE BIENNIUM ENDING JUNE 30, 1920

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
DURHAM, N. H.

THE NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION.

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REPORT OF THE NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION.

For the Biennium Ending June 30, 1920.

In spite of the fact that, so far as finances are concerned, the past two years were ones of extreme stringency, due to the inflated currency and the availability only of Federal appropriations, the New Hampshire Agricultural Experiment Station can report the maintenance of all of its projects.

It has been necessary to curtail the work in many important particulars in order to "live on the same income" as before the war, however, and were it not for the prospect of aid from state sources in the near future, the outlook for the maintenance of research work in agriculture in the state would be a serious one.

It is gratifying to know that, hand in hand with the development of extension work in the state, there has come a deeper appreciation of the value of the research activities which are fundamental to the success of any state-wide agricultural program. People are beginning to realize, as never before, that the peculiar problems of New Hampshire's farming should be put under the microscope, and all knowledge possible gleaned from the study. It has, of course, not been possible to conduct all of the research projects with this end in view, since the Adams projects under the provisions of the Federal act have to do specifically with the fundamental principles of agricultural science. Here, too, we believe that the New Hampshire Station is not in any way to be ashamed of the contribution which it is making, along with the other experiment stations of the country, toward those deeper problems which affect the farm business of the whole nation, and of the world.

Projects.

Projects have been carried on as follows:

Adams Fund.

Department of Animal Husbandry.

(a) Nutrition Studies.
(b) Sheep Breeding.

Department of Botany.

(a) Relative Adhesiveness of the Copper Fungicides.
(b) Studies on the Effect of Fungicides and Insecticides on Plants.
(c) A Study of the Toxic Action of Fungicides to Parasitic Fungi.
(d) Relation of Potassium to Growth in Plants (in co-operation with the Department of Agricultural Chemistry).

Department of Chemistry.

(a) Plant Metabolism Studies.
(b) Relation of Light to Fruit Production (in co-operation with the Department of Horticulture).
(c) Method for the Determination of Arsenic (as part of the project, Studies on the Effect of Fungicides and Insecticides on Plants, in co-operation with the Botany Department.)

Department of Entomology.
(a) Control of Root Maggots by Insecticides.
Department of Horticulture.
(a) Fruit Bud Formation.
(b) Squash Breeding.

HATCH FUND.

Department of Agronomy.
(a) Timothy Selection.
(b) Ensilage Corn Tests.
(c) Oat Variety Tests.
(d) Root Crop Tests.
(e) Sunflower Silage.
(f) Soy Bean Inoculation.
(g) Early Planting of Ensilage Corn.
(h) Winter Wheat and Rye Tests.

Department of Botany.
(a) Snapdragon Rust and Its Control.
(b) Potato Spraying.
(c) Effect of Temperature on the Keeping Quality of Potatoes.

Department of Entomology.
(a) Control of Apple Maggot.
(b) Insect Record.
(c) Control of Termites.
(d) Insecticidal Properties of Hellebore.
(e) Control of Black Flies.

Department of Forestry.
(a) Experiments in Establishing Artificial Forests of Different Species in New Hampshire.
(b) Experiments in Immature White Pine Stands.

Department of Horticulture.
(a) Variety Tests of Fruits.
(b) Experiments in Maintaining Fertility in the Garden.
(c) Pruning Experiment.
(d) Use of Fertilizer in the Peach Orchard.
(e) A Study of the Effect of Phosphorus upon the Time of Maturity Quality, Yield and Chemical Composition of the Tomato Fruit (in co-operation with the Department of Agricultural Chemistry).
(f) Blueberry Culture.

MISCELLANEOUS FUND.

Department of Agronomy.
(a) Seed Tests.

Department of Animal Husbandry.
(a) Steer Feeding Experiment.

Department of Chemistry.
(a) Analyses of Fertilizers.
(b) Analyses of Feed Stuffs.
(c) Analyses of Spray Materials.

Department of Dairy Husbandry.
(a) Advanced Registry Tests.

Department of Poultry Husbandry.
(a) White Diarrhea Tests.

Personnel.

During the past year the staff was maintained practically intact until the close of the year, when the resignations of W. H. Wolff, Assistant Horticulturist, and F. C. Werkenthin, Assistant Botanist, were received. These positions were filled shortly afterward by S. W. Wentworth and W. L. Doran, respectively. Since the close of the year, the Station has suffered a loss in the resignation of J. H. Gourley, Horticulturist, whose work in the Adams Fruit Bud Formation project has been particularly noteworthy. His position has now been filled by Mr. George F. Potter, formerly of the University of Wisconsin. The position of station chemist, which had been vacant for some time, was filled October 25, 1919, by the appointment of Dr. H. R. Kraybill of the Division of Horticulture and Pomology of the United States Department of Agriculture. The work in the chemical laboratory has grown to an extent demanding the services of an assistant chemist, and Mr. C. P. Spaeth has been appointed. During the previous year the position of assistant agronomist was filled by Mr. M. Gale Eastman, and that of executive secretary by Mr. H. B. Stevens.

Publications.

The high cost of printing has materially affected the number of publications which it is possible to issue. It was thought advisable, under the circumstances, to await the close of a biennium before publishing a report on station work; and several other manuscripts are on hand which, it is hoped, may be published soon. The publications issued for the past two years were as follows:

Bulletin No. 190—Sod, Tillage and Fertilizers for the Apple Orchard, by J. H. Gourley.

Bulletin No. 182—Cost of Raising Beef Cattle in New Hampshire, by E. G. Ritzman.

Bulletin No. 191—Inspection of Commercial Feeding Stuffs.

Bulletin No. 192—Annual Report of the Experiment Station.

Bulletin No. 193—Results of Seed Tests.

Bulletin No. 194—Inspection of Fertilizers.

Circular No. 20—Storage of Potatoes, by O. Butler.

Circular No. 21—Can the Farmer Mix His Own Fertilizers? by F. W. Taylor.

Circular No. 22—Spraying for Late Blight of Potatoes, by O. Butler.

Technical Bulletin No. 14—Some Fundamental Factors that Determine Progress in Farm Sheep Breeding, by E. G. Ritzman.

Technical Bulletin No. 15—Comparison of Some Traits of Conformation of Southdown and Rambouillet Sheep, by E. G. Ritzman.

Technical Bulletin No. 16—A Respiration Chamber for Large Domestic Animals, by F. G. Benedict, W. E. Collins, Mary F. Henry, and Alice Johnson.

Scientific Contribution No. 12—The Effect of Environment on the Loss of Weight and Germination of Seed Potatoes During Storage, by O. Butler. Journal of the American Society of Agronomy, 11: No. 3, 114-118, March, 1919.

Scientific Contribution No. 13—The Minimum, Optimum and Maximum Temperature of Spore Germination in Some Uredinales, by W. L. Doran. Phytopathology, v. IX, No. 9, Sept., 1919.

Scientific Contribution No. 14—Relative Adhesiveness of the Copper Fungicides, by O. Butler and T. O. Smith. Phytopathology, v. IX, No. 10, Oct., 1919.

During the past year an information service to the newspapers of the state was started with a view to utilizing more fully this possibility of presenting data of value to the public of the state and news of the activities of the station. Twenty-nine articles were sent out bearing on Station work; and a check on weekly papers showed 600 inches of space secured, with an estimated circulation of 160,000.

Finances.

Following are the financial statements for the past two years:

FINANCIAL REPORT TO THE UNITED STATES GOVERNMENT OF THE HATCH AND ADAMS FUNDS.

	For the year ending June 30, 1919		*For the year ending June 30, 1920*	
	Hatch Fund	*Adams Fund*	*Hatch Fund*	*Adams Fund*
RECEIPTS.				
Cash received from United States Treasurer	$15,000.00	$15,000.00	$15,000.00	$15,000.00
EXPENDITURES.				
Cash paid for salaries	8,532.35	9,635.02	8,937.05	11,367.41
labor	898.95	1,981.94	1,392.84	2,033.10
publications	2,071.71	—	1,778.99	—
postage and stationery	901.82	26.58	573.00	26.82
freight and express	350.78	6.13	236.95	22.37
heat, light, water and power	600.00	—	606.27	4.91
chemicals and laboratory supplies	22.71	154.69	37.96	143.35
seeds, plants, and sundry supplies	459.89	442.65	254.85	396.93
fertilizers	150.19	267.50	28.00	105.00
feeding stuffs	86.17	965.64	136.08	164.88
library	116.80	—	208.37	—
tools, machinery, and appliances	214.65	261.20	324.71	83.60
furniture and fixtures	17.40	18.48	10.45	35.00
scientific apparatus and specimens	19.70	629.49	40.51	176.06
live stock	7.50	15.00	—	—
traveling expenses	508.86	174.54	409.37	140.57
contingent expenses	20.00	—	—	—
buildings and land	20.52	421.14	24.60	300.00
Total	$15,000.00	$15,000.00	$15,000.00	$15,000.00

New Equipment.

With the exception of a new gas machine in the chemical laboratory and the completion of the apparatus used in the studies in basal metabolism, there has been practically no new equipment added during the past year.

RESULTS OF WORK IN ADAMS PROJECTS.

Department of Animal Husbandry

Nutrition Studies.—The first year of the co-operative project with the Nutrition Laboratory of the Carnegie Institution was brought to a close in November, 1919, by sale and slaughter of the steers used in the work.

Up to the time of slaughter these steers had been fed for six months on heavy fattening rations, thus completing the specific objective, namely, a study of the effect of submaintenance on consequent fattening.

SUPPLEMENTARY STATEMENT OF FUNDS RECEIVED FROM OTHER SOURCES THAN THE UNITED STATES.

	For the year ending June 30, 1919			*For the year ending June 30, 1920*		
	Sales	*Miscellaneous*	*Total*	*Sales*	*Miscellaneous*	*Total*
RECEIPTS.						
Balance on hand June 30, 1919	—	—	—	—	$432.88	$432.88
Receipts from other sources than the United States.	$1,695.63	$11,360.74	$13,056.37	$4,186.28	12,765.24	16,951.52
Total	$1,695.63	$11,360.74	$13,056.37	$4,186.28	$13,198.12	$17,384.40
EXPENDITURES.						
Cash paid for salaries	—	$982.20	$982.20	—	$1,650.60	$1,650.60
labor	$387.80	3,409.28	3,797.08	$1,358.23	3,362.88	4,721.11
publications	—	171.63	171.63	—	133.07	133.07
postage and stationery	1.01	752.43	753.44	28.75	126.29	155.04
freight and express	40.17	41.67	81.84	97.23	.48	97.71
heat, light, water and power	—	228.65	228.65	—	956.94	956.94
chemicals and laboratory supplies	—	272.59	272.59	—	575.00	575.00
seeds, plants and sundry supplies	405.81	1,022.33	1,428.14	169.50	1,572.81	1,742.31
fertilizers	—	60.50	60.50	131.05	22.16	153.21
feeding stuffs	339.23	873.02	1,212.25	891.24	762.02	1,653.26
library	—	21.12	21.12	—	45.38	45.38
tools, machinery and appliances	200.96	269.36	4[illegible].32	250.60	337.96	588.56
furniture and fixtures	100.80	277.97	37[illegible].77	—	173.92	173.92
scientific apparatus and specimens	2.35	53.13	5[illegible]	—	542.26	542.26
live stock	—	1,715.61	1,715.61	—	1,257.27	1,257.27
traveling expenses	17.50	681.46	698.96	24.30	860.78	885.08
contingent expenses	—	17.00	17.00	—	45.00	45.00
buildings and land	200.00	77.91	277.91	92.50	168.19	260.69
balance	—	432.88	432.88	1,142.88	605.11	1,747.99
Total	$1,695.63	$11,360.74	$13,056.37	$4,186.28	$13,198.12	$17,384.40

The second year of co-operative research with the Nutrition Laboratory is now also in its closing stage.

This year only two steers were used with the object of making a continuous nitrogen balance under conditions, in respect to feeding, care, etc., exactly duplicating the first year's work.

In terms of practical interpretation the results obtained which will be of value to the farmer will include information on:

1. The composition and digestibility of native hay.
2. Economic rations for maintaining stock through winter.

The results will be reported on in bulletin form sometime during the early part of next year.

Sheep Breeding.—Breeding experiments with domestic animals generally are of necessity a slow procedure where biometry must form the basis of means of observation. With farm live stock, excepting of course pigs, the handicap in obtaining requisite number of offspring on which to formulate reliable deductions on the inheritance of somatic and germinal traits of a breed becomes even greater because of their long periods of gestation and low fecundity.

Accomplishment of the main objective in this work, namely, the production of large numbers of F_2 or second generation of inbred hybrids, has been materially delayed by annual depredations by dogs. However, the present schedule of breeding is nearing its termination since the numbers of F_2 individuals are assuming a proportion sufficient for the purpose of inheritance of conformation and wool characteristics of the two particular breeds represented in the foundation stock. No more F_1 are now produced, as reports on these have been made in Technical Bulletin 15, "A Comparison of Some Traits of Conformation of Southdown and Rambouillet Sheep and of Their Hybrids." The F_2 will form the basis of another bulletin on the inheritance of conformation. A report on the inheritance of wool characteristics is now under preparation and will be published next year.

Department of Botany

Relative Adhesiveness of the Copper Fungicides.—Work on this subject has been completed and reported on in Scientific Contribution No. 14.

Studies on the Effect of Fungicides and Insecticides on Plants.—In continuation of previous work with Bordeaux mixture, the relative transpiration of sprayed and non-sprayed plants was studied, especial attention being given to the behavior of the plants at night.

A Study of the Toxic Action of Fungicides to Parasitic Fungi.—In order to ascertain the value of a fungicide it is essential that it be tested under the conditions most favorable for the germination of the spores of the fungus against which protection is sought. It is, therefore, necessary to know with some exactness the optimum conditions for the germination of the spores before undertaking a study of the effect of toxic agents on germination. For this reason attention has been confined for the present to a study of the minima, optima, and maxima temperatures of germination of a few fungi commonly met with that are difficult to control by chemical agencies; to wit, with æcidio and uredo-spores of *Cronartium ribicola,* æcidiospores of *Gymno sporangium*

clavipes, uredospores of *Puccinia antirrhini* and *Uromyces caryophyllinus*, teleuto-spores of *Puccinia malvacearum*.

The results obtained are indicated in the following table:

CARDINAL TEMPERATURES OF SPORE GERMINATION IN CERTAIN RUSTS.

Spore Used	Cardinal Temperature of Germination		
	Minimum	Maximum	Optimum
Cronartium ribicola { æcidiospores	5°C.	19°C.	12°C.
Cronartium ribicola { uredospores	8	25	14
Gymnosporangium clavipes acediospores	9	29	16
Puccinia antirrhini uredospores	5	20	10
Puccinia malvacearum teleutospores	3	30	14
Uromyces caryophyllinus uredospores	4	29	14

Relation of Potassium to Growth in Plants.—In collaboration with Mr. T. O. Smith, Department of Chemistry, the work on this project was completed during the year, 1919, the following being the conclusions arrived at:

The reserve supply of potassium in the seed is not sufficient to maintain normal growth except for a very short period of time.

Symptoms of potassium starvation appear early in the life of a plant and are characterized by a dwarfing of the axes and progressive death of the foliage, the older leaves succumbing first.

The potassium utilized per gram dry matter formed is higher in plants growing in the presence of potassium than in plants growing in its absence.

The relative distribution of potassium per gram dry matter formed as between the tops and roots is the same whether the plants are growing in the absence of, or presence of potassium.

Recovery from potassium starvation occurs the more slowly the longer the potassium is withheld.

The relative distribution of potassium as between tops and roots per gram dry matter formed is the same whether the plants are growing in the presence of potassium, in the absence of potassium, or have first suffered from a more or less prolonged period of starvation.

Where potassium starved plants are supplied with potassium, the element becomes distributed promptly in accordance with the physiological needs of the plant, the absorption progressing with marked rapidity.

The amount of potassium contained in the seed does not determine the length of time a plant grown from it can live in the absence of potassium without injury resulting.

DEPARTMENT OF CHEMISTRY.

Plant Metabolism Studies.—Nearly all of the different organs or parts of plants (leaves, stems, roots, seeds, bulbs, tubers, etc.) are of economic use. In

fact, crop plants are frequently classified according to the part of the plant which is used commercially.

In many cases all parts of a single plant are of economic value, while on the other hand with certain other crops particular portions of the plants are of such great commercial value that they are grown primarily for those specific parts. Commercially the object to be obtained is the greatest profit, and a big factor in increasing profit is the attainment of a maximum yield consistent with good quality. Some of the parts of a plant such as the leaves, stems, roots, etc., are more closely associated with vegetation, while others such as the fruits (apple, pear, peach, etc.) and the grains, etc., the edible portion of which may be a vegetative structure, are more or less closely associated with reproduction and quite frequently with sexual reproduction. Inasmuch as it has been shown quite definitely that all of our cultural practices such as methods of fertilizing, methods of pruning, methods of tillage, etc., affect materially the type of growth, and, therefore, the yield of the respective portions of the plants, it is important to know how these external factors affect plant metabolism and bring about their respective results.

Work upon the project has just been started.

Relation of Light to Fruit Production.—This project was arranged co-operatively with the Department of Horticulture, April, 1920, and represents a part of the general problem of the Department of Horticulture dealing with the various factors affecting fruit bud formation. Numerous external factors such as the amount of light, the amount and proportion of available mineral nutrients, the moisture supply, the temperature, the manner of pruning, etc., it is generally recognized, affect fruit bud formation and fruit production. All of these external factors affect the internal conditions of the plant and it is believed bring about their respective results by modifying conditions within the plant. A better knowledge of conditions within the plant which are associated with lack of fruit production, as well as those which are associated with fruit production, should aid materially in solving the problem of determining best commercial practices.

The Station is fortunate in having two Yellow Transparent apple trees, which bear at different times in alternate years. A large number of samples have been taken from these trees at different times of the year and are being analyzed.

Method for the Determination of Arsenic.—The Department is co-operating with the Department of Botany upon the project entitled: "Studies on the Effect of Fungicides and Insecticides upon Plants." In studying the relative adhesiveness of insecticides a method for the determination of arsenic in the presence of plant tissues is essential. The department has been working upon this problem, and a promising method has been developed.

Department of Entomology.

Control of Root Maggots by Insecticides.—The insecticidal properties of tobacco dust and lime were the subject of the principal investigations in the Department of Entomology during the summer of 1919. Encouraging progress

was made in determining the repellent qualities of this mixture with reference to the adults of the cabbage root maggot.

Preliminary to the growing season of 1919 a survey of root maggot infestation was made in order to discover a favorable location for the summer's work. During the prior two seasons the species had proved insufficient in number to afford suitable material in the places where experiments were in progress. In the study of this insect, an abundance of material is the first requisite. Following the survey it was determined to transfer the season's work to the southern edge of the town of Pelham, where records showed heavy infestation in 1918. As the crop season of 1919 developed it became evident that the infestation in Pelham would not be as heavy as indicated. Nevertheless, definite and valuable progress was made along certain lines of the investigation.

As in prior years, cabbage and radish were used in the experiments.

Two grades of tobacco dust were employed: one grade a finely powdered dust ground to a condition resembling flour, the other a coarsely ground material containing many granules and pieces of stem an eighth of an inch to a quarter of an inch in length. A comparative study was made of the relative repellent qualities of the two materials.

Analysis of the results showed no considerable difference in repellent qualities, and indicated that the degree of fineness is not a factor of importance in determining the efficiency of the tobacco ingredient, so far as its effects on the adults are concerned.

Further experiments were carried out to disclose the effect of dilution with agricultural lime in varying proportions. The results showed that the repellent qualities of the mixture are not materially decreased by dilution up to two parts of lime to one part of tobacco dust, and the dilution may be carried to four parts of the lime to one part of tobacco dust without serious loss of insecticidal properties.

Throughout the experiments of 1919 a study was made of the relative effects of two applications as compared with one. The results indicated that an efficient degree of repellent protection is better secured by a combination of greater dilution applied twice than by a combination of less dilution applied once. The average percentage of infestation on all check rows on radish in 1919 was approximately 70 per cent. The percentage of infestation in treated rows using the tobacco dust diluted with lime ranged as low as 18 per cent.

In the summer of 1919 preliminary studies were carried out in the insecticidal properties of pyrethrum. The purpose of this was to throw some light on the possibilities of this material with relation to control of root maggots.

Published information as to the insecticidal qualities of pyrethrum is not extensive. The substance has been used for many years and there is much evidence of an inexact nature as to its efficiency in the control of certain insects. The manner in which it may cause the death of an insect, or the possibility of utilizing more efficiently its insecticidal properties, has not been determined in comprehensive investigations.

The work in 1919 included in part experiments in the effect of pyrethrum on plant lice. In these experiments the action of the material was that of a con-

tact insecticide. The study included also experiments in the effect of pyrethrum as a stomach poison, the check insects being house flies.

The investigations of root maggots for the season of 1920 were designed to include new aspects of the study suggested by the work of previous years.

In order to assure a location where material would probably be abundant, five different areas were selected and certain phases of the work were duplicated in each of these.

Since the studies prior to 1920 had proved the existence of definite insecticidal properties in the combination of tobacco dust and lime, the work of 1920 was planned to determine in detail the nature of these properties both with reference to the adults of the root maggots and with reference to the eggs and the larvæ. A series of special cages was constructed. Adults of the cabbage maggot were introduced into these, and a detailed record of the repellent qualities of tobacco dust on the adults was begun. In similar manner, the insecticidal effects of the dry tobacco dust and lime on the egg stage and on the larval stage were made the subject of detailed investigation. A further series of experiments was begun to determine the effect of aqueous infusions of tobacco dust and lime on the larval stage. All of these experiments are intended to determine the nature and the meaning of the data that have been accumulated in the work of the years prior to 1920.

In general it may be stated that the investigation of root maggots has reached the point where the insecticidal value of tobacco dust and lime has been conclusively proved. The detailed reactions that take place are the matters that are now being determined.

Department of Horticulture.

Fruit Bud Formation.—The season of 1920 represents the 13th year during which this experiment has been in progress, and each successive season has added new interest and brought out new evidence in this work. The project is essentially two-fold in its aspect, namely—practical or economic in its general character and technical in its special applications. As indicated in the earlier reports, this work is conducted in a seven-acre Baldwin apple orchard known as the Woodman Orchard. A portion of it is plowed and cultivated each year and a portion is in sod. In addition to tillage some plots have a green crop plowed in annually and some also have various combinations of fertilizer applied. For a number of years there was no apparent effect of the fertilizers on the growth or yield of the trees, but the tillage gave immediate response in both. For the past few years it has become evident that the fertilized blocks of trees were outgrowing those which received no fertilizer, but only in the past year, or possibly two, has there been any evidence that the yield would be increased by the use of fertilizer in the cultivated parts of this orchard. Perhaps the most outstanding feature of the season 1920 is the decided increase in yield throughout all the fertilized plots as compared with the unfertilized ones. In other words, it has taken twelve or thirteen years to obtain any increase from fertilizers and it will require several years more to make the project successful from this standpoint. But again let us point out that the value of ordi-

nary tillage methods in New Hampshire orchards has been established beyond question in this experiment.

There were no insect outbreaks in this orchard this season, and both aphis and red bug, which have been troublesome in some seasons, were entirely under control. The latter part of the season, however, showed a decided outbreak of the New Hampshire Baldwin fungus spot (Brookes), which marred the appearance of the fruit attacked. This is the second time in the past eight years that this disease has been present in sufficient amount to cause damage. For a summarized statement of the results of this experiment, the reader is referred to Station Bulletin No. 190.

The sub-project, "Relation of Light to Fruit Production," has been pursued and extended this year in co-operation with the Chemistry Department, and has been reported by that department.

Ringing.—In order to obtain data on the changes within the tissues of a fruiting and non-fruiting tree, some trees were ringed in May of 1919 and 1920 in order to secure material for this purpose. The trees used in 1919 were young and undernourished, so that the ringing resulted in the death of part of them, while those remaining alive bloomed quite full and afforded material for analysis. The trees were better selected in 1920, and in the fall showed every evidence of being full of fruit buds and the trees in good condition.

Squash Breeding Experiment.—The material used up to 1920 was apparently impure, and the experiment was started over again along different lines in the spring of 1920, with a view toward selection of pure and early strains of certain ones of our commercial squashes, particularly Delicious and Hubbard. No data are at present available.

RESULTS OF WORK IN HATCH PROJECTS.

Agronomy Department.

Timothy Selection.—This work, which has been in progress for several years, was continued last season by setting out 2000 new plants in hills 3 feet apart each way. These plants were secured from the seed of the 20 best plants in the previous selection series. About one and one-half bushels of seed were threshed from the multiplying plot seeded in the fall of 1919 from the 20 best plants mentioned above. It is planned to seed a larger multiplying plot during the season of 1921, and to send some of this selected seed to farmers in various sections of the state for trial plots.

Ensilage Corn Tests.—Of ensilage corn seventeen different varieties were planted in 1919. The heaviest yield was secured from Eureka, 17.3 tons per acre, with ears just forming. The lightest yield was from Stowell's Evergreen, with only 7 tons per acre. The most promising of the newer varieties was Early Lakeside, with a yield of 12.3 tons and ears in the dough stage. A table is available showing the composition of the silage made from the various varieties, as reported by the Chemistry Department.

In 1920 one and one-half quarts of each of seven varieties were sent to 20 different farmers in the state through the county agents. The object of the test was to determine the relative yield, maturity and adaptability of the sev-

eral varieties in the different sections of the state. The farmers were to grow other local or favorite varieties alongside of these in the test, and seed of these other varieties was sent to the Station for planting. The yield per acre was to be determined by weighing 3 representative lots of 10 stalks each and calculating upon the basis of a given stand per acre. At the Station the different varieties were cut and put in the silo for the purpose of determining any differences in the composition of the resulting silage.

The following varieties were in the test: Eureka, Leaming, Clarage, Early Lakeside, N. H. 500, Cornell No. 11, Luce's Favorite, Bloody Butcher, Davis' Flint, Sweepstakes, Pride of Michigan, Excelsior, Gold Nugget, and Sanford.

Oat Variety Tests.—Oat variety tests were conducted in 1919 on the College Farm, and in co-operation with the County Farm Bureaus, at St. Paul's School, Concord, at Walpole, Holderness and Lancaster. Eight standard varieties were grown on plots varying from one-eighth to one-quarter acre. The highest yield secured was 82.7 bushels per acre with the Swedish Select at Concord. The average yield per acre at the five locations for grain and straw was as follows:

	Grain in Bushels.	*Straw in Tons.*
Swedish Select	52.4	1.18
Lincoln	50.6	1.83
White Tartar	49.2	1.67
O. A. C. No. 72	48.6	1.46
Mammoth Cluster	48.4	1.71
Gem of Michigan	48.4	1.33
King Oats	45.8	1.54
Worthy	45.0	1.76

Seven standard varieties of oats were planted on one-fifth acre plots at the rate of 3 bushels per acre, on June 4, 1920. The oats were harvested August 30. A similar lot of the same varieties was sent to the St. Paul's School farm at Concord for testing.

The data for the yields in the Station tests were as follows:

Variety	Type	Average Height	Straw	Date Ripe	Grain per Acre	Straw per Acre
Gem. of Michigan	Sp	41 in.	Med.	Aug. 23	35.7	1.08
White Tartar	Side	45 "	Stiff	" 28	34.3	1.10
Swedish Select	Sp.	42 "	Med.	" 23	35.5	1.01
Banner	Sp.	40 "	Med.	" 23	32.4	1.02
Clydesdale	Sp.	42 "	Med.	" 23	39.5	1.00
O. A. C. No. 72	Sp.	44 "	Med.	" 29	38.6	1.12
Silvermine	Sp.	40 "	Med.	" 25	35.4	1.04

Root Crop Test.—A test of nine varieties of turnips, rutabagas and mangels was made on one-sixtieth acre plots of three rows each, with the rows 30 inches apart.

Six of the varieties were furnished by H. P. Winter & Co., representatives of Sutton and Long of England. The other three varieties were purchased of Ross Bros. The roots were planted May 21, 1920, but owing to unfavorable weather a poor stand was secured, and all the plots were replanted June 7. One plot, the Imperial Green Globe turnip, planted May 21, had a fairly good stand and was allowed to remain.

Varieties of Root Crops 1920.

Plot No.	Variety	Yield per Acre in Tons
1	Imperial Green Globe (planted May 21)	26.4
2	Imperial Green Globe (planted June 7)	21.3
3	Perfection Green-top Aberdeen	15.45
4	Up-to-date Swede	18.45
5	Magnum Bonum Swede	27.6
6	Klein Wanzleben (Ross Bros.)	11.0
7	Mammoth Long Red (Ross Bros.)	18.9
8	Golden Tankard (Ross Bros.)	15.3
9	Golden Tankard (Sutton)	14.4
10	Prizewinner Mangold	13.8
11	Long Island Improved Rutabaga	24.45
	Roots pulled and weighed, Nov. 1	

Sunflower Silage.—As a preliminary test of sunflowers for silage, one-third acre of the Giant Russian variety was planted in 1919. The seed was planted at the same time as the ensilage corn, but a little thicker. The sunflowers came along faster than the corn and seemed to withstand the dry weather better. The earliest frost damaged the corn to some extent, but did not injure the sunflowers. They were cut September 23 and yielded 16½ tons per acre, which was above the average of the ensilage corn in the same field.

The sunflowers were cut and put in the silo with corn below and above. The silage was fed out in January, and it was noted that the cows, especially those giving a heavy flow of milk, did not seem to relish it the first day or two, but seemed to take more kindly to it later. A mixture of corn and sunflower silage in the ratio of 2 to 1 seemed to make a good combination. A chemical analysis of the silage just completed shows the following composition: Water, 81.3 per cent; Protein, 1.7 per cent; Fat, .8 per cent; Ash, 1.6 per cent; Crude Fiber, 5.8 per cent; Nitrogen Free Extract, 8.8 per cent.

About two acres of sunflowers were planted for silage in the spring of 1920. They were planted thicker than the year before, with the idea of keeping the stalks smaller in size. As a consequence, they grew to a height of 12 and 13 feet, with the stalks so small that many of them broke over and made harvesting a slow and difficult process. The yield per acre was about 40 per cent larger than that of corn planted on adjoining ground.

While the value of sunflowers for ensilage in this state is still undetermined

definitely, their growth and further trials seem warranted in those sections where corn is too uncertain.

Soy Bean Inoculation.—Four different commercial cultures were used to inoculate the various sections of a plot of soy beans. All the inoculated sections could be detected by the eye on account of the greener color of the foliage. All of the inoculated sections also showed an abundance of nodules on the roots, while the uninoculated showed few, or none. From this and other previous tests it seems quite evident that where soy beans are grown for the first time on a given piece of ground inoculation is strikingly beneficial.

Early Planting of Ensilage Corn.—It has been contended for several years by the Bureau of Plant Industry that larger yields and a better quality of silage could be obtained in the more northern latitudes of corn culture by planting the later maturing varieties several weeks earlier than the usual planting season. In order to test this theory two late varieties of corn (a dent, U. S. 119, and a flint, U. S. 193) were furnished by the Bureau. A high, well-drained piece of stony loam soil (the Heater lot) was selected for the test. Two rows of each variety were planted in 1920 at four different dates, as follows: April 27, May 7, May 17, and May 27. The plantings were made heavy and later thinned to an average of one stalk per foot.

The first planting required 18 days to come up, the second 14 days. The second and third plantings were soon as tall as the first. On August 18 the tassels began to appear, and no difference in the first three plantings could be noted as to their frequency. No tassels appeared on the fourth planting until August 20.

All the plots were cut October 5, and several interested parties were asked to pick out the plantings in order. The last planting was fairly obvious, because the ears were not quite as hard and mature as the others. No differences, however, could be noted in the stage of maturity of the three earlier plantings.

The season was an unusual one, in that there were no frosts in the spring after the first planting was up and none in the fall until after the corn was cut. On the basis of this one season's results one cannot say that any advantage was gained by the unusual early plantings. It is hoped that the test may be repeated for further observations on the question at issue.

Variety Tests of Winter Wheat and Rye.—In the winter wheat tests on one-sixth acre plots eight varieties were tested. These were seeded October 4 and harvested July 18. The yields of grain and straw per acre were as follows:

	Grain in Bushels.	*Straw in Tons.*
Ohio No. 9920	39.5	1.78
Ohio No. 13850	35.6	1.64
Fultz	31.6	1.75
Gladden	31.1	1.70
Trumbull	31.0	1.60
Dawson's Golden Chaff	28.0	1.35
Valley	26.7	1.76
Illinois Red	25.0	1.64
Rosen Rye	44.6	1.95

Botany Department.

Snapdragon Rust and Its Control.—During 1919 the effect of temperature on the germination of snapdragon spores was studied as well as the effect of temperature on the duration of the incubation period. In field experiments on the control of the disease the following fungicides were used: cuprammonium sulphate, cupric acetate, sulphur, and sulphur containing 12 per cent bisulphite of soda. The weather during the greater part of the growing season was cold, and the copper fungicides afforded the best protection.

In 1920 field experiments were made on the control of snapdragon rust by means of calcium polysulphide, sulphur, and sulphur plus varying percentages of soot. The results obtained indicate that sulphur affords better protection than calcium polysulphide, but that contrary to the opinion generally current, the addition of soot to sulphur did not increase its efficiency.

Potato Spraying.—During 1919 an experiment was undertaken to determine the effect of strength of Bordeaux mixture on the number of applications required to give the best control of late blight. A report of the results has been published in Station Circular No. 22. It was found that absolute protection is afforded when between 24.7 pounds and 26 pounds of metallic copper are applied per acre, and that whether this amount is applied in weekly or fortnightly sprayings the results obtained are substantially the same. It was also found that 1 per cent Bordeaux mixture 1:0.5 is superior to 1 per cent Bordeaux mixture 1:1 for the control of late blight; 2 per cent Bordeaux mixture 1:0.5 applied fortnightly is superior to both 1 per cent Bordeaux mixture 1:0.5 and 1:1 applied every week, and that of the two proprietary copper fungicides experimented with, the one giving a mixture rich in copper was superior to the one giving a mixture weak in copper.

Effect of Temperature on the Keeping Quality of Potatoes.—During 1919 the work on this project was brought to a close. The results have been published in Station Circular 20.

Entomology Department.

Control of Apple Maggot.—Further experiments in the effect of poison sprays on the adults of the apple maggot were planned for the summer of 1920. In a preliminary survey six areas were selected near Durham in which the apple maggot was on record as being injurious in 1919 and in which spraying experiments promised facts of interest.

Control of the apple maggot by means of spraying with poison bait for the adults has been a subject of investigation by several entomologists. At the New Hampshire Station comprehensive studies in this phase of apple maggot control were carried out through several consecutive years. The results indicated that under conditions prevailing in New Hampshire there was apparently no satisfactory benefit to be derived from spraying for the adults. It was determined to repeat these spraying experiments in 1920.

The areas selected are well adapted for securing reliable data. Three of the areas are so isolated by fields, strips of woodlands, and other barriers that it is considered impossible that adults of this species might fly to the sprayed trees

in any number from unsprayed trees. The spray schedule includes both single and double applications.

Insect Record.—Under this project, which has been running continuously for several years, there is opportunity to follow out two lines of study:

The first of these includes a complete cross-index record of injurious insects reported within New Hampshire. These records, which have now been maintained for several years, show the geographical location of the various species, the relative abundance and the food plants. Where records of this nature are maintained for a considerable period of years and are compared with other available records as to meteorological conditions and similar data, information of general interest and of scientific value is disclosed.

The second opportunity afforded is that of detailed study of a species that unexpectedly exhibits unusual abundance. Under this phase of the project an investigation was begun in 1919 in the control of termites which were found to be seriously infesting a New Hampshire hospital. This investigation is described below.

Control of Termites.—Early in the spring of 1919 a report reached the department that termites, or so-called white ants, had been found in destructive numbers in the basement of a New Hampshire hospital. Arrangements were made to investigate the situation and to attempt measures of control.

The termites were first discovered beneath a doorsill in the first floor of the main or administration building of the hospital. On removal of a partition in the basement, just beneath, it was found that the studding was honey-combed. Several of the main beams supporting the building were then found thoroughly infested, and it was discovered that the termites were at work in remote parts of the building and had already caused extensive and exceedingly serious damage. An investigation of the area surrounding the buildings was begun and other colonies, or other parts of the same colony, were discovered.

Timbers and partitions were removed. Experiments were undertaken to determine the possibility of eradicating the insects within beams, partitions and flooring by means of treatment with heat. The degree and duration of high temperature necessary was found to be practical. Arrangements were made to install temporary radiation. The entire basement of the main building was then treated with heat, and check observations maintained throughout the treatment disclosed that it was successful.

Further studies were undertaken to discover efficient barriers to prevent further increase of termites into the buildings. These studies are still under way. At the close of the work the data secured will be prepared for publication.

Insecticidal Properties of Hellebore.—Supplementary to a part of the investigation of the control of root maggots by insecticides, it was found feasible to undertake a study of some properties of powdered hellebore. Although this material has been in use as an insecticide for many years, its actual properties have not been accurately determined. The investigation included the following lines of inquiry: the availability of dried diluents of the powdered hellebore; effect of dry heat on the insecticidal properties; value of aqueous extracts;

value of alcoholic and ethereal extracts; repellent properties; poisonous properties with relation to vertebrates.

Control of Black Flies.—Biological observations made up the work under this project during the period. In order to secure a larger volume of data concerning the relative abundance of various species of black flies in the state, collections of larvæ were made at numerous points and the species determined.

Department of Forestry.

Artificial Forests.—This project is intended to secure data upon the growth and yield of exotic tree species which are suitable to New Hampshire climatic conditions. These plots were started in 1913, so that they are beginning to show results.

Thinning of Immature Stands.—Twenty-six sample plots have been established under this project in the vicinity of Durham. They are being remeasured annually. The data from these plots can be used directly in estimating yields on farm woodlots.

Department of Horticulture.

Variety Testing of Fruits.

Thompson Apple Orchard.—Records of blossoming and yields were kept this season. The most notable feature of this variety orchard is that all the originally planted McIntosh trees have grown well, and are now fruiting well on soil conditions which are usually held to be not at all suited to apple culture. On a wet stiff clay soil that killed out the original Baldwin trees and succeeding lots of trees planted between the McIntosh this latter variety has thrived.

Several varieties fruited for the first time this past season in this orchard—notably, Liveland Raspberry, Delicious, and Northern Spy. The "Delicious" were of fair size and very good quality. The trees in general are now making better growth than they have in the past, owing to the added fertility which is being supplied from poultry droppings. During the summer the hens and chickens have full run of the orchard.

The Plum Orchard.—This orchard did not produce a crop during the season of 1920, owing to the killing of practically all the fruit buds during the previous winter. During the previous years the outstanding feature has been the success of the variety Burbank.

Strawberries. The variety plots of strawberries yielded well this past season, and records were made of the character of the blossoms, the nature of the foliage, and condition of the plants together with the total yield in quarts for each variety.

A bulletin covering the strawberry work at the Station together with notes secured from growers throughout the state has been prepared for publication.

Raspberries and Blackberries.—This experiment comprises a fertilizer and manure test on two rows of Cuthbert, one row each of Marlboro, Perfection and Herbert raspberries, and on one row of Snyder blackberries. Six plots, approximately one-tenth acre each, are laid out crossing these varieties, and fertilizer and manure treatments have been applied. There was a very evident

effect on the plants last year from both nitrate and phosphate, but the yield was not sufficient to warrant taking records. This experiment should give definite information on the value of fertilizers and manures on New Hampshire soils.

Grapes.—A new vineyard constituting 411 vines of 15 varieties was planted in 1919. The vineyard is in good condition and should begin to bear next year. Up to date the Lucile variety has made the best growth and given the best stand of plants of any variety included.

Blueberries.—Work on propagation of blueberries was continued during the season 1920.

Experiment in Maintaining Fertility in the Garden.—This experiment was started in the spring of 1918. Prior to that the land had been plowed and planted to potatoes, and was treated uniformly throughout. It was then laid off in one-eighth acre plots measuring 155 by 35 feet. One half of each plot is treated with ground limestone at the rate of 2000 pounds per acre every other year in addition to the other fertility applied.

The treatments of the different plots are as follows:

Plot 1—32 tons of manure per acre.
Plot 2—24 tons of manure per acre and the following commercial fertilizer per acre: 150 pounds tankage; 100 pounds nitrate of soda; 600 pounds acid phosphate, 150 pounds muriate of potash.
Plot 3—Green manure plus the following commercial fertilizers per acre: 160 pounds nitrate of soda; 250 pounds tankage; 800 pounds acid phosphate; 300 pounds muriate of potash.
Plot 4—16 tons of manure and the same fertilizer treatment as Plot 3.
Plot 5—Check plot.
Plot 6—8 tons of manure and the same fertilizer treatment as Plot 3.
Plot 7—Green manure plot.

In 1918 the plots were planted to Red Kidney beans. The total yield was in almost direct proportion to the amount of manure applied to the plots, but there was no increase from commercial fertilizer. Plot 7, which was the green manure plot, did not receive any treatment because the experiment was just started and there was insufficient time to grow a green crop to plow under.

In 1919 the crop grown was sweet corn, and yield records for both ears and stover were taken. The same fertilizer treatments were used as in 1918. The effects of the lime were quite apparent.

The striking lesson thus far obtained was the remarkable response which all crops made to manuring the land. On the other hand, the response from chemical fertilizers without the use of manures on a green crop was very small. The 1919 season, however, was very dry, and a fair test from the fertilizers could scarcely be expected.

In 1920 the plots were planted to potatoes, and the results showed increased yields from the use of chemicals. The largest yield was on Plot 6. More manure, as used on Plots 1, 2 and 4 did not increase the yield.

Pruning.—A pruning experiment in the apple orchard at the Horticultural Farm is being continued, and the trees are attaining sufficient size to show very interesting results. The types of pruning include the following:

Block I—Pruned to vase-shaped trees.
Block II—Pruned to semi-leaders.
Block III—Pruned to leaders.
Block IV—Pruned to leaders.
Block V—Summer pruned.

The first orchard, which was planted in 1918, has made a very good growth, and shows much larger trees where the least pruning is done.

Use of Fertilizer in the Peach Orchard.—The fertilizer experiment in the peach orchard has been continued, and it is interesting to note that this year for the first time there is a decided evidence of the use of fertilizer. The trees where nitrogen is used are more vigorous, are larger, and have better foliage than where none is used, but it is yet too soon to see the effect of omitting either phosphorus or potash from the fertilizer.

Vegetable Storage.—The work in pit storage during the past year was conducted with leaves instead of hay as insulation material. Carrots, beets, potatoes, and cabbage were stored with varying amounts of protection and temperature records obtained.

Tomatoes.—A variety test of forcing-tomatoes has been continued for several years in the greenhouses. In 1919 twelve varieties and strains were planted, and individual yield records were kept for each plant in the house. John Baer was the highest yielding of any included in the test. However, this variety is not of the type that is desired on the Boston market. The Marvel ran too small, and the Belmont was such a poor producer that both proved worthless under our conditions. Bonny Best, Lister's Prolific and Balshire were the highest yielding varieties of a type that is desired on this market. Other varieties tried were: Peerless, Lord Roberts, Grand Rapids, Comet, and Globe.

With regard to tomatoes grown out of doors, the season confirmed previous observations that it is very necessary to have early maturing varieties of tomatoes for New Hampshire conditions. The Sunny Proof Earliana strain yielded more ripe tomatoes than any other kind, with Chalk's Jewell a second.

In 1920 an experiment was conducted on eight plots with fertilizers on tomatoes. The results showed beyond question the value of phosphorus in growing this crop. One thousand pounds of phosphorus produced a bigger yield than either 500 or 1500, while the use of potash proved injurious. Manure was applied on all except the check plot at the rate of 20 tons per acre.

MISCELLANEOUS PROJECTS.

In 1920 the Agronomy Department made purity and germination tests of 570 samples of grass and grain seeds for farmers, county agents, dealers, and the State Department of Agriculture; also about 40 tests of soils for lime for farmers throughout the state. The Chemistry Department analyzed 110 fertilizer samples, 307 samples of commercial feeding stuffs, and 10 samples of spray materials for the State Department of Agriculture. For the first time arrangements were made with the Bureau of Chemistry, U. S. Department of Agriculture, in connection with the adulteration or misbranding of feed stuffs in interstate shipments; and 10 samples were reported to the Department during the year. Over 100 analyses of feed stuffs, fertilizers, insecticides

and fungicides, lime, wood ashes, etc., were also made for individual farmers in the state.

The Dairy Department continued its Advanced Registry work, with 178 cows on yearly test and 49 on seven-day tests.

Work in analyses and tests similar to the above was also done the preceding year.

Steer Feeding Experiment.—The steer-feeding experiment with the Texas-bred Herefords, begun in December, 1917, was brought to a close at the end of the pasture season of 1919, when the cattle were shipped to the Brighton market.

The first year's operation has already been reported in Station Bulletin No. 182.

The results of the experiment show that as a matter of practice in winter feeding between heavy and light rations it would seem that feeding a small surplus of protein and carbohydrates over what would be required for maintenance during winter is more economical than feeding a ration that forces growth, provided the animals are turned on good pastures the following season. It also seems that it pays to force growth during winter only when the fattening period is to follow immediately.

White Diarrhea Tests.—The white diarrhea work at the New Hampshire Station was started in the winter of 1918. It was hoped that some funds might be obtained from the Legislature that winter to do the work, but no money was appropriated. Nevertheless, the work was started and 4000 samples taken the first year. During the second year over 11,000 samples were taken.

The work is self-supporting. The poultrymen are charged 10 cents for each bird tested, this covering all the laboratory expenses, the salary of the tester in the laboratory and the traveling expenses involved in taking the samples.

As a result of the tests the loss of chicks from stock which has been tested has been less by 29 per cent than in previous years when no testing was done.

The total number of chicks hatched in the state in a year is approximately 1,000,000. If the mortality can be lowered from an unusually high figure to a normal or low figure by means of the white diarrhea testing, the saving will surely run into many thousands and the effect of the work will go on for many poultry generations. Many of our poultrymen have reported losses as high as 60 per cent of all the chicks hatched in years before the testing was done and losses since the testing running as low as 5 to 8 per cent.

Furthermore, there have been located in the state several commercial flocks of various breeds which are free from the disease, so that many farmers and poultrymen have been able to purchase eggs and chicks from white diarrhea free stock. The effects of the testing will continue through several future years and the benefits will cover an ever-widening area.

Practically all the men whose flocks have been tested one year have sent to the Station to have them tested a second year.

To show how general the disease is, the following figures were taken from last year's testing:

Number of flocks tested.....	60	Number of birds tested ...	13,059
Number of flocks infected.....	42	Number of birds infected..	999
Per cent of flocks infected.....	60	Per cent of birds infected..	7.66